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14. ABSTRACT
This report outlines the project technical goals and strategy to approach the reliability assessment from 3 technical directions: 1) Direct prediction of fatigue damage, 2) Prediction of exceeding specified load thresholds, and 3) Simulation and prediction of Ocean waves.

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Reliability Assessment of Ship Structures against Fatigue
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The accomplishments of the research project are advancements in the state of knowledge in the reliability assessment of ship structures against fatigue. Fatigue life of ship structural components is believed sensitive to load events exceeding certain thresholds. Ocean waves are known to be the dominant source of fatigue in ship structures. Thus, this fatigue investigation has spanned three technical areas: direct prediction of fatigue damage in non-Gaussian load environments, prediction of probability of exceeding specified load thresholds in non-Gaussian environments, and simulation and prediction of non-linear, non-Gaussian ocean waves. Some of the methods developed are applicable to many different structural types beyond ship structural components. In these cases, the methods have been additionally tested and verified against wind-turbine fatigue data because turbine-blade fatigue data was available to the project.

In the predicting fatigue damage in non-Gaussian load environments, research has concentrated on the fitting of up to three statistical models to observed load data and on application of these models to predict long-term fatigue accumulation from short-term observed data. A broad variety of statistical models have been fit using the method of moments, and the resulting models have been tested against measured data for ship fatigue and for wind-turbine blade fatigue applications.

In the prediction of exceeding specified load thresholds, use of four-moment Hermite models, analytic formulae, first-order reliability method (FORM), statistical bootstrapping methods, and fitting of various statistical models have all been proposed and tested against measured physical data. Numerical algorithms in the form of computer software have been developed as in an effort to more fully understand these phenomena. Example applications have included prediction of extreme statistics of wind-driven ocean waves, and of motions of a spar production platform subject to these waves.

In the prediction of non-linear non-Gaussian ocean waves, a methodology has been developed to simulate second-order random ocean waves to match a target sea spectrum. The inverse has also been developed: identifying the first- and second-order components underlying a specified wave time-history. The results of both the simulation and identification methodologies can be used to predict consistent wave time-histories at other spatial locations. Results of this methodology have been verified against observed wave time-histories both from field data and from model test measurements.

Reports of these methods and results have been documented in numerous papers and reports. The reports generated from research funded by this project are:

1. RMS-19: Steven R. Winterstein, "The FITS Routine: Fitting Distributions to Multiple Databases and Estimating Combined Extremes" June 1996
2. RMS-22: Alok K. Jha and Steven R. Winterstein, "Wavemaker 2.0: Simulation and Identification of Second-Order Random Waves" June 1996
3. RMS-24: Alok K. Jha, "Nonlinear Random Ocean Waves: Prediction and Comparison with Data" June 1997
4. RMS-25: Alok K. Jha, "Spar Floating Platform: Numerical Analysis and Comparison with Data" June 1997
5. RMS-26: Alok K. Jha, "Non-Linear Ship Loads and Fatigue Reliability" June 1997
6. RMS-27: Alok K. Jha, Steven R. Winterstein, "Cycles 2.0: Fatigue Reliability Models and Results form Wave and Wind Applications" June 1997
7. RMS-33: Bert Sweetman, Alok K. Jha, Steven R. Winterstein, "Second-Order Random Ocean Waves: Prediction of Temporal and Spatial Variation. The Routine WAVEMAKER" June 1998
8. RMS-34: Ron de Jong and Steven R. Winterstein, "Probabilistic Models of Dynamic Response abd Bootstrap-Based Estimates of Extremes: the Routine MAXFITS" June 1998
9. RMS-36: P. Ron de Jong, "Prediction of Extreme Responses form Limited Data" June 1999
10. RMS-37: Bert Sweetman, Steven R. Winterstein, "Second-Order Random Ocean Waves: Prediction of Temporal and Spatial Variation from Fixed and Moving References" May 1999
11. RMS-39: LeRoy M. Fitzwater and Steven R. Winterstein, "Estimation of Extremes from Limited Time-Histories: The Routine MAXFITS with Wind Turbine Examples" May 2000